1

METHOD AND SYSTEM FOR
RATE ADAPTIVE ISDN COMMUNICATION

TECHNICAL FIELD OF THE INVENTION

This invention relates generally to computer and telecommunications networks and more particularly to method and system for rate adaptive ISDN communication.

BACKGROUND OF THE INVENTION

Data communication is becoming increasingly important in today's society. A prevalent use of data communications occurs between a person located at home seeking to interact
5   over the Internet with remote computers. Conventionally, connections between the person's home computer and the remote computers through the Internet take place over conventional telephone wires. Such communications are limited in speed, resulting in less than desirable data
10   communication.

Various alternatives to such communications have been implemented. One group of techniques utilizes existing telephone lines, but with improved digital transmission technology that allows communication of data at higher
15   speeds. One example is a synchronous digital subscriber line technology (ADSL). According to ADSL, bandwidth available on existing telephone wires is utilized at higher frequencies than standard voice communication. Other techniques involve introducing alternative media
20   connections between the home user and remote computers for use on the Internet. One example is the use of cable. Another involves special telephone lines, such as ISDN. An ISDN line transmits data digitally, rather than in analog form. An ISDN telephone line uses existing copper
25   telephone wire, but requires special ISDN digital switches.

Communication over traditional phone lines conventionally uses a modem. A modem stands for modulator/demodulator and enables a computer to transmit information over a standard telephone line. Because a
30   computer is digital and a conventional telephone line is analog, modems are needed to convert digital to analog and vice versa. In the case of ISDN, no analog to digital conversion is required. However, devices known as ISDN Terminal Adapters and ISDN Routers are used to communicate

DAL01:572516.1

with the phone company ISDN line interfaces and other ISDN devices.

ISDN lines utilize two main types of channels: a B channel, which carries data at a rate of 64 kilobytes per second (Kbps) and a D channel, which carries control information at 16 Kbps. Basic Rate Interface (BRI) ISDN lines include two B channels. These two B channels then combine to transmit data at 128 Kbps. However, some lines utilize the additional 16 Kbps D channel to transfer for a total of 144 Kpbs of data.

Establishing a connection between two IDSL line interfaces is often problematic. Both because the bandwidth of the particular ISDN line utilized may vary and because a bit rate of either line interface at the customer premises or the remote location may differ. Conventionally, in order to set up an IDSL router at a customer's premises, a technician or user had to call the central office and determine the bit rate applicable to the corresponding IDSL line interface at the central office. Such a procedure is time consuming and cumbersome.

SUMMARY OF THE INVENTION

Accordingly, a need has arisen for a method and system for rate adaptive ISDN communication. The present invention provides a method and system for rate adaptive ISDN communication that addresses shortcomings of prior systems and methods.

According to one embodiment of the invention, an IDSL line card includes at least one line interface having an adjustable bit rate. The line card includes a microcontroller operable to control a bit rate associated with the at least one IDSL line interface. The microcontroller includes a processor and a memory associated with the processor storing a rate adapter application. The rate adapter application is operable, when executed on the processor, to receive an error level associated with transfer of data through at least one IDSL line interface, determine that the received error level exceeds a maximum error level, and in response to determining that the maximum error level is exceeded, adjust the bit rate for at least one IDSL line interface and determine that a resulting error level falls below the maximum error level.

According to another embodiment of the invention, a method for communicating data according to ISDN protocol includes connecting a first IDSL line interface to a second IDSL line interface at a location remote from the first IDSL line interface, the first IDSL line interface having a first bit rate, and the second IDSL line interface having a second bit rate. The method also includes transmitting data between the first IDSL line interface and the second IDSL interface, determining that a CRC level associated with the data transfer exceeds a predetermined acceptable level, and lowering the second bit rate until a CRC level associated with subsequent data transfer between the first

and second IDSL line interfaces meets or falls below the
predetermined acceptable level.

   Embodiments   of   the   invention   provide   numerous
technical advantages. For example, some embodiments of the
present invention allow automatically adapting the bit rate
at which an IDSL line interface will transfer data until
such data communication occurs with an acceptable amount of
error.   Such automation allow for more rapid and less
cumbersome setup of IDSL communications, for example, a
home office and a central office.

   Other technical advantages are readily apparent to one
skilled   in   the   art   from   the   following   figures,
descriptions, and claims.

BRIEF DESCRIPTION OF THE DRAWINGS

For a more complete understanding of the present invention and the advantages thereof, reference is now made to the following descriptions taken in connection with the accompanying drawings in which:

FIGURE 1 is a block diagram of a communications system implementing an automatic rate adapter according to the teachings of the present invention;

FIGURE 2 is a block diagram of the digital subscriber line access multiplexor (DSLAM) shown in FIGURE 1;

FIGURE 3 is a block diagram illustrating an IDSL modem of the DSLAM of FIGURE 2;

FIGURE 4 is a block diagram of a microcontroller on the IDSL modem of FIGURE 3;

FIGURE 5 is a block diagram of an ISDN chipset of FIGURE 3; and

FIGURE 6 is a flowchart showing steps performed by the rate adapter of FIGURE 4 in automatically adjusting the bit rate of the IDSL line interface of FIGURE 3 until acceptable error rates occur, according to the teachings of the invention.

DETAILED DESCRIPTION OF THE INVENTION

Embodiments of the present invention and its
advantages are best understood by referring to FIGURES 1
through 6 of the drawings, like numerals being used for

5   like and corresponding parts of the various drawings.

FIGURE 1 is a block diagram of a communications system
10 according to the teachings of the invention.
Communications system 10 allows communication between a
user and a communications network over ISDN lines.

10   Communication system 10 includes customer premises
equipment 12 and a customer premises equipment IDSL router
14. Customer premises equipment 12 may include, for
example, a personal computer. Customer premises equipment
IDSL router 14 performs necessary conversions and

15   translations of data received from customer premises
equipment 12 to allow communication over an IDSN line. An
example of a customer premises equipment IDSL router is
Cisco Model No. 802, available from Cisco Systems.
Communication system 10 also includes a digital subscriber

20   line access multiplexor 16 in communication with or located
within a central telecommunications office 18. Central
telecommunications office 18 includes hardware and software
associated with transmitting and receiving data between a
customer premises and a network, such as network 20. A

25   typical implementation of network 20 is the Internet;
however, other networks may be used.

Data are communicated between customer premises
equipment 12 through customer premises equipment IDSL
router 14 to DSLAM 16 over ISDN lines 22. ISDN lines 22

30   are digital telephone lines allowing transmission of data
in digital form. Communication between customer premises
equipment 12, such as a computer, and customer premises
equipment IDSL router 14 occurs over line 26, which may
take the form of an ethernet cable. An example of line 26

DAL01:572516.1

is an ethernet cable. Communication between DSLAM 16 and
other portions of central office 18 may occur over line 28.
An example of line 28 is an optical interface, connecting
DSLAM 16 to other portion of central office 18. Central
5   office 18 communicates with network 20 over line 30, which
may include of optical interfaces.

DSLAM 16 includes a plurality of central office IDSL
line cards 24. As described in greater detail below,
central office IDSL line cards 24 include a plurality of
10   line interfaces, each used to control data communications
with a respective customer premises equipment IDSL router
14. According to one embodiment, IDSC line cards 24,
include software configured to automatically adjust a bit
rate at which the central office IDSL line interface 32
15   communicates with the associated customer premises
equipment IDSL router 14. Such automatic adjustment allows
communications within acceptable error levels without
manual adjustment of the bit rate setting of the IDSL line
interface 32 at the central office. Therefore, the
20   teachings of the invention allow a rapid and cost effective
provisioning of IDSL communications.

Additional details on implementation of communications
system 10 for communicating data over an ISDN line are
described in greater detail below in conjunction with
25   FIGURES 2 through 6. FIGURES 2 through 5 show example
structure associated with one embodiment of implementing
such a rate adaptive procedure, and FIGURE 6 shows a series
of steps associated with one example method of automatic
rate adaptation.

30   FIGURE 2 is a block diagram of DSLAM 16 showing
additional details of the DSLAM. As described above, DSLAM
16 includes a plurality of central office IDSL line cards
24. An example of a central office IDSL line card suitable
for use with the present invention is Cisco Model No. ITV-

DAL01:572516.1

C, available from Cisco Systems. In this example, central
office IDSL line card 24 includes eight IDSL line
interfaces 32. In this example, each IDSL line interface
32 is associated with one customer premises equipment IDSL
5   router 14 for effecting communication between customer
premises equipment 12 and central office 18. Central
office IDSL line cards 24, and therefore line interfaces
32, communicate over line 34 with a network interface card
35. Network interface card 35 is well known in the
10 telecommunications industry and provides suitable
formatting for providing information along line 30 to
network 20 and for receiving data from network 20 over line
30. An example network interface card suitable for use
with the present invention is Cisco Model No. NI-2,
15 available from Cisco Systems.

As described above, line interfaces 32 may have
different bit rate settings to control the speed at which
line interfaces 32 transfer or receive data. The speed of
line interface 32 needs to match the associated speed of
20 the customer premises equipment IDSL router 14 associated
with customer premises equipment 12 in order for
communication between the two to occur within acceptable
levels. As described above, according to the teachings of
the invention, the bit rate at which line interface 32 is
25 set is adjusted automatically until suitable levels of
errors are met. Logic for implementing such a bit rate
adaptive procedure is located, in this embodiment, on line
card 24, as described in greater detail in conjunction with
FIGURE 3; however, such logic may be implemented in other
30 locations, such as a personal computer or other suitable
location.

FIGURE 3 is a block diagram of line card 24
illustrated in FIGURE 2. As described in conjunction with
FIGURE 2, line card includes a plurality of ISDN line

interfaces 32. In addition, line card 24 includes an ISDN
chipset 36 and a microcontroller 38. ISDN chipset 36 is
well known in the art and controls communication between
customer premises equipment IDSL router 14 and line 22

5   according to ISDN protocol. Microcontroller 38 controls
ISDN chipset 36 and the automatic bit rate adaptation
according to the teachings of the invention, as described
in greater detail below.

       As illustrated, in this example ISDN chipset 36

10   communicates with line interfaces 32 over line 40, and ISDN
chipset 36 communicates with microcontroller 38 over a PCM
interface 42. In this manner, microcontroller 38 may
communicate with modems 32 through ISDN chipset 36 and
thereby effect bit rate adaptation. Alternatively a

15   separate communication link 44 may be provided that allows
communication directly between microcontroller 38 and line
interfaces 32. Logic for implementing the bit adaptation
is contained, in this embodiment, in microcontroller 38, as
described in greater detail below in conjunction with

20   FIGURE 4.

       FIGURE 4 is a block diagram of microcontroller 38. An
example microcontroller suitable for use with the present
invention is a Motorola MPC860P, available from Motorola;
however, other suitable microcontrollers may be used.

25   Microcontroller 38 includes a processor 44, a memory area
46, and additional circuitry 48. According to the
teachings of the invention, stored in memory location 46 is
a rate adapter application 50. Rate adapter application 50
includes suitable logic for automatically adjusting a bit

30   rate of a line interface 32 until suitable error levels are
reached. Additional circuitry 48 may include serial
communications controller 51 running QMC protocol for
communication over PCM interface 42. Example steps
associated with rate adapter application 50 are described

DAL01:572516.1

in greater detail below in conjunction with Figure 6.
Additional details of one example of ISDN chipset 36, which
form a part of line card 24, are described below in
conjunction with FIGURE 5.

5   FIGURE 5 is a block diagram of ISDN chipset 36 of
FIGURE 3. ISDN chipset 36 includes U-transceiver 46, which
enables full duplex data transmission at the U reference
point, line 40. A PCM Interface Controller 54 is also
included which provides necessary conversions to
10   transmit/receive data from ISDN chipset 36 over PCM
interface 42 to microcontroller 38.

          FIGURE 6 is a flowchart illustrating example steps
associated with automatically adjusting the bit rate of
central office line interfaces 32 to match the bit rate of
15   customer premises equipment IDSL router 14. The method is
described in the context of rate adapter application
executing on microcontroller 38 within line card 24 in this
example; however, other hardware and software
implementations may be utilized without departing from the
20   scope of the present invention. For example, separate
controllers may be utilized to effect such a method or a
personal computer connected to line interfaces 32 may be
used.

          The method begins at step 100. At step 102, an HDLC
25   frame associated with ISDN data communications is received.
HDLC refers to High-Level Data Link Control Stream and
includes cyclic redundancy check (CRC) data identifying an
error level associated with data communications between
IDSL routers 14 and line interfaces 32.

30   At a step 104, a determination is made whether the
received CRC error level exceeds a given threshold. The
threshold utilized depends upon the level of error
acceptable to the customer or to the operator of the
central office, or other suitable entity; however, a

DAL01:572516.1

suitable CRC error level useful for use with the present
invention is 2048 bytes. If the error level is acceptable,
the process ends at 112; however, if the error level is not
acceptable, determination is first made of whether there

5　　are any other acceptable bit rates available for line
interface 32, at step 106.

　　　　As described in greater detail below, one way of
determining a subsequent bit rate to try is to access a bit
rate table designating the various bit rates that may be

10　　applied.　A sample bit rate table reproduced below;
however, other suitable tables, if tables are used at all,
may be used. However, if there are no bit rates left on
the access table, determination is made at step 106 that
the end of the bit rate table has been met. In such a

15　　case, a default bit rate 110 is set and processing ends at
step 112.　Setting a bit default rate at step 110 may
include setting the lowest possible bit rate for line
interface 32. If such occurs, manual confirmation of the
bit rate of both ISDN router 14 and line interface 32 may

20　　be implemented to determine the appropriate bit rate.　If
a bit rate table has not been exhausted at step 106, the
bit rate is adjusted at step 108 and the CRC error level is
reset at step 109.

TABLE 1: Sample Bit Rate Table

Index	Speed (bps)
1	56000
2	64000
3	128000
4	144000

25

30

　　　　Adjusting the bit rate generally comprises reducing
the bit rate associated with central office line interface
32; however, other schemes may be utilized. For example,

instead of using a high bit rate and reducing the bit rate
for line interface 32 until an acceptable CRC level is set,
a low bit rate may be initially chosen and incremented
until the CRC level is exceeded, at which point the
previous bit rate that provided data communication within
acceptable error levels would be utilized. After adjusting
the bit rate of line interface 32 at step 108, data
communications proceeds and process continues at step 102
until an appropriate error level is reached.

     Although the present invention and its advantages have
been described in detail, it should be understood that
various changes, substitutions, and alterations can be made
therein without departing from the spirit and scope of the
present invention as defined by the appended claims.